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Supporting Information

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Fully-Loaded Micromotors for Combinatorial Delivery and Autonomous Release of Cargoes

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Supplementary Materials:

Materials and Methods: Synthesis of cargo-loaded micromotors: Cyclopore polycarbonate membranes, containing 2 μm diameter conical-shaped micropores (Catalog No 7060-2511; Whatman, Maidstone, U. K.), were used as templates. A 75 nm gold film was first sputtered on one side of the porous polycarbonate membrane to serve as the working electrode using the Denton Discovery 18 Sputter System. Solutions of 500 nm SiO_2 particles (Bangs Laboratories, IN), diluted 60 or 15 fold, were passed through membrane pores by vacuum infiltration[1,2]. A polycarbonate membrane with pore sizes of 200 nm was placed below the 2 μm diameter polycarbonate membrane (with the sputtered Au side down) to retain the SiO_2 particles within the upper 2 μm membrane pores. The membrane was then assembled in a plating cell with aluminum foil serving as a contact. A Pt wire and an Ag/AgCl (3 M KCl) served as counter and reference electrodes, respectively. Zinc was electrodeposited using a potential of -1.2 V for a total charge of 8 C, from a plating solution consisting of 68 g/L $ZnCl_2$, and 20 g/L H_3BO_3 (pH 2.5, adjusted with sulfuric acid). After the Zn deposition, the sputtered gold layer was removed by mechanical polishing of the surface with 3-4 μm alumina slurry. The membrane was then dissolved in methylene chloride for 3 min to completely release the micromotors. The micromotors were collected by centrifugation at 3000 rpm for 3 min and washed repeatedly with methylene chloride, ethanol and water (two times of each). The SiO_2 loaded micromotors were then ready to be used. For longer

storage times, the micromotors were kept in ethanol. Mixtures of 20 nm Au nanoparticles (Ted Pella, Inc., Redding, CA) and SiO_2 particles and a combination of 2 different sizes of SiO_2 particles (500 and 250 nm) were used for fabricating the multi-cargo loaded micromotors. For the binary Au-SiO_2 cargo mixture, the Au nanoparticles (from the 2 mL commercial solution) were preconcentrated by centrifugation. The top layer of the supernatant was removed to a final volume of 200 μL. The Au nanoparticles were then redispersed in a 10X diluted 500 nm SiO_2 particle solution. For the binary SiO_2 loading, 500 nm and 250 nm SiO_2 particles were mixed at a volume ratio of 1:2, followed by a 10 fold dilution. Zinc was electroplated after infiltrating these particles using the deposition conditions described earlier.

Equipment: Template electrochemical deposition of the micromotors was carried out with a CHI 660D potentiostat (CH Instruments, Austin, TX). Scanning electron microscopy (SEM) images were obtained with a Phillips XL30 ESEM instrument, using an acceleration potential of 20 kV. Metal analysis was performed using an Oxford Energy-dispersive X-ray (EDX) attached to the SEM (Phillips XL30 ESEM instrument), which was operated by Inca software. The propulsion of the cargo-loaded micromotors was examined in HCl solutions containing 1.6% Triton X-100. Videos were captured at 45 frames per second by an inverted optical microscope (Nikon Instrument Inc. Ti-S/L100), coupled with a 40x objective, a Hamamatsu digital camera C11440, using the NIS-Elements AR 3.2 software.

References

1. F. Li, J. He, W. L. Zhou, J. B. Wiley, Synthesis of porous wires from directed assemblies of nanospheres, *J. Am. Chem. Soc*. **2003**, *125,* 16166.
2. F. Li, X. Badel, J. Linnros, J. B. Wiley, Fabrication of colloidal crystals with tubular-like packings, *J. Am. Chem. Soc*. **2005**, *127,* 3268.

Supplementary Movies:

Movie S1. Propulsion of a single Zn micromotor along with a dynamic release of the payload in a 0.7 M HCl solution.

Movie S2. Propulsion of multiple Zn micromotors along with a dynamic release of the payload in a 0.7 M HCl solution.

Movie S3. Controlled cargo release from fully-loaded micromotors in a 0.3 M HCl solution.